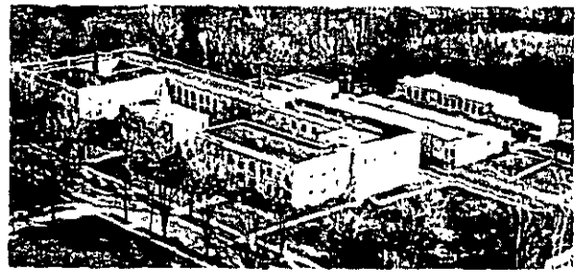

THE INSTITUTE OF PAPER CHEMISTRY, APPLETON, WISCONSIN

COMPARATIVE PERFORMANCE STUDY

Project 2392

Report Two

A Preliminary Report

to

FOURDRINIER KRAFT BOARD INSTITUTE, INC.

January 21, 1965

THE INSTITUTE OF PAPER CHEMISTRY

Appleton, Wisconsin

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COMPARATIVE PERFORMANCE STUDY

Phase I of the Comparative Performance Study was initiated at The Institute of Paper Chemistry on behalf of the Fourdrinier Kraft Board Institute, Inc , for the purpose of evaluating the comparative performance of combined board and boxes made from both European and domestic components, manufactured according to their traditional specifications, and fabricated by a United States converter The Comparative Performance Study as initially outlined involves two phases – Phase I, as described above; and Phase II, which is concerned with the fabrication and evaluation in Europe of combined board and boxes made from the same lot of component materials. This design or arrangement permits Phase I to be undertaken and, which if successful, could then proceed logically into Phase II

The scope of Phase I relative to material combinations is shown in Fig. 1 This represents a significant enlargement of the scope as originally proposed It may be noted that Phase I involves the fabrication of four weights of domestic linerboard – 26, 33, 38, and 42-lb. – and four competitive weights – 25 6, 30 8, 35 9, and 41 0-lb – of European liners, from each of two manufacturers, with both 26-lb domestic and 23-lb. European semichemical corrugating medium into A- and B-flute combined board and boxes. In addition, the four domestic liner samples were fabricated with a sample of European 26-lb semichemical medium into A-flute combined board and boxes The fabrication was carried out on one corrugator – Menasha Corporation, Menasha, Wisconsin – and the same conditions were used where possible. Starch was used as the adhesive and the combined boards were made into boxes (RSC) size 11-3/4 by 8-3/16 by 9-3/4 inches A portion of the boxes of each sample was stitched and the balance was taped. This size box corresponds to a No 24, 12-oz juice container

The size was selected so as to comply with the carrier specifications both here and abroad for boxes made with 25.6 and 26.0-lb liners.

The domestic linerboards and corrugating medium were selected such that their qualities were representative of the general or average quality board currently produced in these particular grade weights.

As previously mentioned, two sets of European linerboards were selected. These were Enso Gutseit (E.G.) of Finland and Svenska Cellulosa (S.C.) of Sweden. The 23 and 26-lb. semichemical corrugating mediums came from Fiskeby and Finnkarton, respectively. In order to maintain as great a degree of anonymity as possible, the European components were obtained via an European affiliate of Container Corporation of America through the efforts of Mr. Spachner The materials were ordered by and delivered to the affiliate company which in turn reshipped the materials. A sufficient quantity of materials, both domestic and foreign, were obtained to carry out Phase II, if it is deemed advisable The domestic components are currently in storage at Appleton, Wisconsin, and the European components in Hamburg, Germany.

The boxes, combined boards and components resulting from the fifty-two different material combinations were evaluated at two atmospheric conditions. One representing standard conditions in this country (50% relative humidity at 73°F) and the other representing standard conditions in Europe (65% relative humidity at 68°F.).

Prior to evaluation, each box, combined board and component sample was randomized and preconditioned for 24 hours in an atmosphere maintained at 35% relative humidity at 73°F After the prescribed preconditioning, each sample was conditioned in the respective standard conditions for at least 48 hours and then tested in the same atmosphere.

During the fabrication of the fifty-two different material combinations, sample strips the full width of each component roll were taken at the start and end of each material combination. The start and end samples of each component for each material combination were tested separately and the test results averaged to give a characterization of the quality of the components used in each material combination The properties of the components measured at each of the two atmospheric conditions are listed below together with the procedures used:

1	Basis weight	T 410	1000 sq. in.
2.	Caliper	T 411	10
3.	Apparent density	T 411	--
4.	Bursting strength	IPC 906	10 (5 up, 5 down)
5.	Elmendorf tearing strength	T 414	10 each way
6.	Torsion tear	IPC 913	10 each way
7.	Puncture	T 803	10 (5 each way)
8.	Modified ring	IPC 918	10 each way
9.	Taber stiffness	T 489	10 each way
10	Tensile	T 404	10 each way
11.	Stretch		10 each way
12	Modulus of elasticity	--	10 each way
13.	Tensile energy absorption or work	--	10 each way
14.	Transverse bond strength	--	5 each way
15	Porosity	T 460	5
16	Smoothness (Bendsten smoothness)	--	5 (felt side)
17	Cobb size	T 441	5

Further, for the purpose of obtaining a rough comparison of the type of furnish and the degree of refining, each component material was subjected to fiber analysis, specie identification, and fiber length. In addition, Canadian freeness determinations were made on a sample of each component. The freeness determinations were made as follows:

The sample of component (liner or medium) was conditioned at 50% relative humidity to constant weight A total of 26 grams of fiber was weighed out and torn into small pieces (approximately one inch square) The thus

A. BOX PERFORMANCE

The box performances measured in terms of compression strength and resistance to rough handling have been summarized in Tables II through V and illustrated in Fig 2 It may be recalled (see Fig 1) that the study involved the fabrication of twelve different liners each fabricated with 26-lb. domestic semichemical medium and 23-lb. European semichemical medium, into A- and B-flute combined board and boxes. For purposes of preliminary review, the box performance data have been tabulated in Tables II through V to show the comparative performance at the four different weight levels on the following basis.

1. Liners fabricated with 26-lb. domestic medium into A-flute combined board and boxes
2. Liners fabricated with 26-lb. domestic medium into B-flute combined board and boxes.
3 Liners fabricated with 23-lb European medium into A-flute combined board and boxes
4. Liners fabricated with 23-lb. European medium into B-flute combined board and boxes.
5. Composite average of all A- and B-flute boxes

The box compression performance may be noted from the top- and end-load results tabulated in Tables II and III at 50 and 65% R.H., respectively, and illustrated in Fig. 2.

It may be observed that on an over-all or composite basis, the boxes fabricated with domestic liners appear to give about the same compression performance at 50 and 65% R.H. as the boxes made with the European liners When the results at the different liner weight levels are considered, however, it

When the drum results are considered it may be seen that on an over-all average basis there is a tendency for the results obtained on boxes fabricated with U.S liners to be better than the corresponding results for boxes fabricated with E G. liners. This is more evident in the results at 65% R.H. In the case of the results obtained on boxes fabricated with S.C. liners it may be noted that there appears to be no significant difference between the performance of boxes made with U.S. liners and S C. liners.

Aside from the exception noted above which may have arisen because of the inherent variability associated with these rough handling tests as well as the material variability, it appears that the boxes made with U.S. liners exhibit rough handling resistance equal to that manifested by the corresponding boxes made with E G and S C liners. In general, the boxes made with S.C liners exhibit better rough handling performance than the boxes made with E.G liners.

In Tables VI and VII the torsion tear results on the unscored area of the board are shown as the average of in- and cross-machine. It may be observed that, in practically all cases, the boards made with U.S. liners exhibit higher average torsion tear than the corresponding samples made with European liners. On an over-all average basis, the average torsion tear results for the combined board made with U.S. liners are 8 and 10% higner at both humidity levels than the corresponding boards made with E G. and S C. liners, respectively

When the scoreline torsion tear results are considered, it may be seen that, as was noted for average torsion tear, in practically all cases the combined board made with U.S. liners yield higher test results than the corresponding combined board samples made with European liners. On an over-all average basis, the combined boards made with U S liners are 5 to 7% higher than the corresponding boards made with European liners. The foregoing is at best only a very modest difference and is not reflected to any marked degree in the box rough handling performance.

Earlier studies carried out on behalf of the co-operator have shown that top-load box compression may be predicted with reasonable accuracy from a consideration of two basic combined board properties and the load perimeter ($2\underline{L} + 2\underline{W}$) of the box according to the relationship given by Equation (1):

$$P = 2.028\ P_m^{0.746}\ (\sqrt{D_x D_y})^{0.254}\ Z^{0.492} \qquad (1)$$

when

$$d/Z \geq 1/7$$

where $\underline{P}$ = top-load box compression, lb.

$\underline{P_m}$ = combined board cross-machine edgewise compression, lb /in.

liner; thus, the flexural stiffness of the liners governs this type of failure. Flexural stiffness of the liner is a function of EI (modulus of elasticity and the moment of inertia). The modulus of elasticity of the liner decreases slightly as the relative humidity increases whereas the moment of inertia, which is a function of the caliper cubed, increases because the caliper of the liner increases at the higher humidity. The net result is that the increase in I more than offsets the decrease in E.

As mentioned earlier in this report, previous studies carried out at The Institute of Paper Chemistry have shown that top-load box compression is dependent on two basic combined board properties and the load perimeter as indicated by Equation (1). In order to determine the efficiency of this relationship when applied to the present study, top-load box compressions were calculated from the combined board results by means of Equation (1) and also an abridged form of Equation (1) which is based on an empirical relationship. The form of the abridged relationship is given in Equation (2):

$$P = 5.87\ P_m\ h^{0.508}\ Z^{0.492} \qquad (2)$$

where

P = top-load box compression, lb.

P_m = combined board cross-machine edgewise compression, lb./in.

Z = box load perimeter (2L + 2W), inch

h = combined board caliper, inch

The predicted and observed top-load compression results are tabulated in Tables VIII and IX. It may be noted that Equations (1) and (2) predict top-load box compression very well for the B-flute boxes; however, the results obtained for the A-flute samples at 50 and 65% R.H. exhibit considerably more "error" than has been experienced heretofore when applied to A-flute board.

On the basis of the combined board data presented the following trends may be noted:

1. The combined boards made with U S. liners are 3 to 5% heavier in basis weight.

2. On the average, the bursting strength of the combined board made with U.S. liners are 25 to 30% lower than on the corresponding samples made with European liners

3. In general, the puncture strength of combined boards made with U.S. liners is about 4% higher than for the "foreign" board samples. This difference is probably not sufficient to influence box performance noticeably.

4. As noted above for puncture, the torsion tear characteristics of the combined board fabricated with U.S liners average 5 to 10% higher than the results obtained on the combined boards made with European liners. This difference apparently is not sufficient to cause a significantly higher rough handling box performance

5 The edgewise compression characteristics of the combined boards, which is the primary combined board property governing box compression, fabricated with U.S. liners are on an over-all average not significantly different from the corresponding samples made with European liners. However, there is a tendency for the combined boards made with European liners to exhibit lower edgewise compression characteristics than the domestic boards at the lower liner weight levels but slightly higher compression results at the higher liner weight levels

6. The geometric mean of the combined board flexural stiffness which is the second material property of importance in box compression, is on the average approximately 8 and 24%, respectively, higher for the combined board fabricated with C.S. and E.G. liners than on the board fabricated with U.S liners.

4. The bursting strength of the European liners averages 28 to 32% higher than the U.S liners at both 50 and 65% R.H. It may be recalled that this is approximately the same difference as was obtained on the combined board On a strength-weight basis the European liners develop 36 to 43% more bursting strength per pound of basis weight

5. The average machine-direction Elmendorf tearing strength of the U.S. liners is 10 to 15% higher than the strength of the European liners and the cross machine is 12 to 20% higher. In general, the S.C. liners have the lower tearing strength of the two European liners. The contrast between domestic and European liners is quite clearly shown by the bursting strength and tearing strength The European liners as a result of the type of fiber and degree of refining are characterized by high bursting strength and low tearing strength in contrast to the U S liners

6. The torsion tearing strength and the puncture test results show much the same trend as the Elmendorf tearing strength results

7 In contrast to Elmendorf tearing strength, puncture, and torsion tear which are primarily dependent on fiber length; the edgewise compression strength as measured by the modified ring compression is slightly higher in most cases on the European samples In addition, it may be seen that the European liners exhibit a better strength-fiber weight efficiency than do the U.S. liners. This was also observed in the case of the bursting strength.

8 There is no clear trend indicated by the Taber stiffness results

9 As in the case of bursting strength, the tensile strength of the European liners range from 30 to 50% higher than the U.S. liners. The cross-machine difference is the greatest and it is felt that this characteristic is the one which in combination with machine-direction combined board torsion tear governs the rough handling performance. It may be recalled that the combined

15 The European liners are considerably smoother than the U.S liners

16. Although the European liners are noticeably more dense and less porous to air, the degree of sizing as measured by the Cobb size test indicates that the U.S. liners are slightly better sized than the European liners.

The physical properties of the three corrugating mediums used in this study are tabulated in Table XIII

The foregoing has been a preliminary presentation of some of the primary results obtained in the study. At the present time the results are being analyzed and the final report is in preparation

TABLE I

FIBER CHARACTERISTICS OF LINERBOARD SAMPLES

Sample	Fiber Analysis		Specie	Av. Fiber Length, mm.[a]	C.S. Freeness, cc.[b]
U.S. 26-lb. liner	S.W. unbleached kraft	85%	Southern pine	2.51	595
	H.W. unbleached kraft	15%	Gum		
U.S. 33-lb. liner	S.W. unbleached kraft	95%	Southern pine	2.41	585
	H.W. unbleached kraft	5%	Mainly gum but trace of oak, beech, maple and yellow poplar		
U.S. 38-lb. liner	--	--	-- --	--	625
U.S. 42-lb. liner	S.W. unbleached kraft	85%	Southern pine	2.52	565
	H.W. unbleached kraft	15%	Gum		
E.G. 25.6 liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.19	560
	H.W. kraft	trace	Birch		
E.G. 30.7-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.23	530
	H.W. kraft	trace	Birch		
E.G. 35.8-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.20	560
	H.W. kraft	trace	Birch		
E.G. 41.0-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.18	595
	H. W. kraft	trace	Birch		

TABLE I, continued

FIBER CHARACTERISTICS OF LINERBOARD SAMPLES

Sample	Fiber Analysis		Specie	Av. Fiber Length, mm.[a]	C.S. Freeness, cc.[b]
S.C. 25.6-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.22	510
	H.W. kraft	trace	Birch		
S.C. 30.7-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.32	570
	H.W. kraft	trace	Birch		
S.C. 35.8-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.20	560
	H.W. kraft	trace	Birch		
S.C. 41.0-lb. liner	S.W. unbleached kraft	100%	Scotch pine 90% Norway spruce 10%	2.27	530
S.C. 41.0-lb.	H.W. kraft	trace	Birch		
U.S. 26-lb. medium	S.W. unbleached kraft H.W. unbleached NSSC	15% 85%	Southern pine Gum	1.40	455
Eur. 23-lb. medium	S.W. unbleached kraft	15%	Scotch pine 90% Norway spruce 10%	1.24	485
	H.W. unbleached NSSC	85%	Birch		
Eur. 26-lb. medium	--	--	--	1.37	600

[a] Weighted average fiber length

[b] Determined on defibered board

TABLE II

BOX COMPRESSION PERFORMANCE

(50% Relative Humidity)

Run	Flute	Type Medium	Top-Load (0-0.75 in.), lb. U.S. Liner	E.G. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]	End-Load (0-0.5 in.), lb. U.S. Liner	E.G. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]
				25.6, 26-lb. Liners								
3, 2, 6	A	26-lb. U. S.	530	510	- 3.8	520	- 1.9	270	245	- 9.3	255	- 5.6
3, 2, 6	B	26-lb. U. S.	460	445	- 3.3	440	- 4.3	330	340	+ 3.0	345	+ 4.5
4, 1, 5	A	23-lb. European	565	520	- 8.0	530	- 6.2	255	230	- 9.8	255	0.0
4, 1, 5	B	23-lb. European	465	435	- 6.5	435	- 6.5	330	320	- 3.0	320	- 3.0
Average			505	478	- 5.3	481	- 5.1	296	284	- 4.1	294	- 0.7
				30.7, 33-lb. Liners								
10, 7, 11	A	26-lb. U. S.	595	615	+ 3.4	610	+ 2.5	345	350	+ 1.4	340	- 1.4
10, 7, 11	B	26-lb. U. S.	545	545	0.0	525	- 3.7	480	410	-14.6	440	- 8.3
9, 8, 12	A	23-lb. European	590	595	+ 0.8	625	+ 5.9	350	335	- 4.3	355	+ 1.4
9, 8, 12	B	23-lb. European	545	555	+ 1.8	515	- 5.5	420	415	- 1.2	415	- 1.2
Average			569	578	+ 1.6	569	0.0	399	378	- 5.3	388	- 2.8
				35.8, 38-lb. Liners								
15, 14, 18	A	26-lb. U. S.	635	690	+ 8.7	640	+ 0.8	400	405	+ 1.2	385	- 3.8
15, 14, 18	B	26-lb. U. S.	565	600	+ 6.2	590	+ 4.4	535	520	- 2.8	435	-18.7
16, 13, 17	A	23-lb. European	660	675	+ 2.3	630	- 4.5	400	415	+ 3.8	390	- 2.5
16, 13, 17	B	23-lb. European	560	635	+13.4	585	+ 4.5	460	495	+ 7.6	425	- 7.6
Average			605	650	+ 7.4	611	+ 1.0	449	459	+ 2.2	409	- 8.9
				41, 42-lb. Liners								
23, 19, 22	A	26-lb. U. S.	730	775	+ 6.2	715	- 2.1	455	470	+ 3.3	495	+ 8.8
23, 19, 22	B	26-lb. U. S.	600	640	+ 6.7	640	+ 6.7	590	610	+ 3.4	535	- 9.3
24, 20, 21	A	23-lb. European	725	815	+12.4	740	+ 2.1	440	485	+10.2	490	+11.4
24, 20, 21	B	23-lb. European	575	630	+ 5.7	650	+13.0	535	600	+12.1	575	+ 7.5
Average			658	715	+ 8.7	686	+ 2.7	505	541	+ 7.1	524	+ 3.8
Overall Average			584	605	+ 3.6	587	+ 0.5	412	415	+ 0.7	403	- 2.2

[a] Based on U. S. liner results as reference.

TABLE III

BOX COMPRESSION PERFORMANCE

(65% Relative Humidity)

Run	Flute	Type Medium	Top-Load (0-0.75 in.), lb. U.S. Liner	E.C. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]	End-Load (0-0.5 in.), lb. U.S. Liner	E.C. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]
				25.6, 26-lb. Liners								
3, 2, 6	A	26-lb. U. S.	490	465	- 5.1	470	- 4.1	235	210	-10.6	235	0.0
3, 2, 6	B	26-lb. U. S.	405	425	+ 4.9	405	0.0	310	305	- 1.6	305	- 1.6
4, 1, 5	A	23-lb. European	520	515	- 1.0	455	-12.5	225	220	- 2.2	220	- 2.2
4, 1, 5	B	23-lb. European	450	420	- 6.7	395	-12.2	290	280	- 3.4	305	+ 5.2
Average			466	456	- 2.1	431	- 7.5	265	254	- 4.2	266	+ 0.4
				30.7, 33-lb. Liners								
10, 7, 11	A	26-lb. U. S.	560	540	- 3.6	545	- 2.7	330	305	- 7.6	305	- 7.6
10, 7, 11	B	26-lb. U. S.	495	510	+ 3.0	495	0.0	420	355	-15.5	415	- 1.2
9, 8, 12	A	23-lb. European	540	545	+ 0.9	575	+ 6.5	305	305	0.0	335	+ 9.8
9, 8, 12	B	23-lb. European	500	480	- 4.0	470	- 6.0	395	385	- 2.5	380	- 3.8
Average			524	519	- 1.0	521	- 0.6	362	338	- 6.6	359	- 0.8
				35.8, 38-lb. Liners								
15, 14, 18	A	26-lb. U. S.	600	605	+ 0.8	625	+ 4.2	360	370	+ 2.8	340	- 5.6
15, 14, 18	B	26-lb. U. S.	535	570	+ 6.5	570	+ 6.5	480	485	+ 1.0	455	- 5.2
16, 13, 17	A	23-lb. European	600	610	+ 1.7	615	+ 2.5	345	400	+15.9	350	+ 1.4
16, 13, 17	B	23-lb. European	510	620	+21.6	525	+ 2.9	445	475	+ 6.7	370	-16.9
Average			561	601	+ 7.1	584	+ 4.1	408	432	+ 5.9	379	- 7.1
				41, 42-lb. Liners								
23, 19, 22	A	26-lb. U. S.	670	750	+11.9	685	+ 2.2	420	440	+ 4.8	430	+ 2.4
23, 19, 22	B	26-lb. U. S.	570	620	+ 8.8	580	+ 1.8	540	555	+ 2.8	555	+ 2.8
24, 20, 21	A	23-lb. European	675	735	+ 8.9	625	- 7.4	410	470	+14.6	430	+ 4.9
24, 20, 21	B	23-lb. European	515	600	+16.5	580	+12.6	550	540	- 1.8	530	- 3.6
Average			608	676	+11.2	618	+ 1.6	480	501	+ 4.4	486	+ 1.2
Overall Average			540	563	+ 4.3	538	- 0.4	379	381	+ 0.5	372	- 1.8

[a] Based on U. S. liner results as reference.

TABLE IV

ROUGH HANDLING PERFORMANCE
(50% Relative Humidity)

Run	Flute	Type Medium	Drop, falls					Drum, falls				
			U.S. Liner	E.G. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]	U.S. Liner	E.G. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]
						25.6, 26-lb. Liners						
3, 2, 6	A	26-lb. U. S.	9.1	9.4	+ 3.3	6.5	-28.6	84	77	- 8.3	75	-10.7
3, 2, 6	B	26-lb. U. S.	6.2	6.1	- 1.6	5.0	-19.4	56	56	0.0	51	- 8.9
4, 1, 5	A	23-lb. European	6.6	6.9	+ 4.5	5.0	-24.2	67	45	-32.8	67	0.0
4, 1, 5	B	23-lb. European	4.8	5.1	+ 6.2	3.8	-20.8	45	48	+ 6.7	25	-44.4
Average			6.7	6.9	+ 3.0	5.1	-23.9	63	57	- 9.5	55	-12.7
						30.7, 33-lb. Liners						
10, 7, 11	A	26-lb. U. S.	10.1	9.4	- 6.9	10.5	+ 4.0	110	99	-10.0	118	+ 7.3
10, 7, 11	B	26-lb. U. S.	6.5	6.8	+ 4.6	8.2	+26.2	63	62	- 1.6	87	+38.1
9, 8, 12	A	23-lb. European	8.7	7.8	-10.3	10.5	+20.7	110	56	-49.1	87	-20.9
9, 8, 12	B	23-lb. European	5.6	6.6	+17.9	6.8	+21.4	42	43	+ 2.4	60	+42.9
Average			7.7	7.7	0.0	9.0	+16.9	81	65	+19.8	88	+ 8.6
						35.8, 38-lb. Liners						
15, 14, 18	A	26-lb. U. S.	12.2	10.8	-11.5	13.8	+13.1	154	122	-20.8	146	- 5.2
15, 14, 18	B	26-lb. U. S.	10.1	8.5	-15.8	11.2	+10.9	88	76	-13.6	116	+31.8
16, 13, 17	A	23-lb. European	11.6	8.9	-23.3	11.0	- 5.2	120	91	-24.2	106	-11.7
16, 13, 17	B	23-lb. European	8.2	7.7	- 6.1	8.7	+ 6.1	74	68	- 8.1	74	0.0
Average			10.5	9.0	-14.3	11.2	+ 6.7	109	89	-18.3	111	+ 1.8
						41, 42-lb. Liners						
23, 19, 22	A	26-lb. U. S.	13.3	13.2	- 0.8	12.7	- 4.5	144	151	+ 4.9	141	- 2.1
23, 19, 22	B	26-lb. U. S.	9.9	9.6	- 3.0	10.7	+ 8.1	94	96	+ 2.1	82	-12.8
24, 20, 21	A	23-lb. European	10.4	11.5	+11.5	10.1	- 2.9	110	131	+19.1	116	+ 5.5
24, 20, 21	B	23-lb. European	8.0	9.2	+15.0	8.9	+11.2	77	54	-29.9	95	+23.4
Average			10.4	10.9	+ 4.9	10.6	+ 1.9	106	108	+ 1.9	109	+ 2.8
Overall Average			8.8	8.6	- 2.3	9.0	+ 2.3	90	80	-11.1	90	0.0

[a] Based on U. S. liner results as reference.

TABLE V

ROUGH HANDLING PERFORMANCE

(65% Relative Humidity)

Run	Flute	Type Medium	Drop, falls					Drum, falls				
			U.S. Liner	E.G. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]	U.S. Liner	E.G. Liner	Diff., %[a]	S.C. Liner	Diff., %[a]
						25.6, 26-lb. Liners						
3, 2, 6	A	26-lb. U. S.	11.4	11.3	- 0.9	10.9	- 4.4	92	82	-10.9	81	-12.0
3, 2, 6	B	26-lb. U. S.	8.6	9.2	+ 7.0	7.1	-17.4	52	55	+ 5.8	50	- 3.8
4, 1, 5	A	23-lb. European	8.1	8.6	+ 6.2	7.4	- 8.6	62	55	-11.3	53	-14.5
4, 1, 5	B	23-lb. European	6.9	7.3	+ 5.8	6.8	- 1.4	51	54	+ 5.9	33	-35.3
Average			8.8	9.1	+ 3.4	8.0	- 9.1	64	62	- 3.1	54	-15.6
						30.7, 33-lb. Liners						
10, 7, 11	A	26-lb. U. S.	13.0	12.0	- 7.7	14.4	+10.8	99	93	- 6.1	102	+ 3.0
10, 7, 11	B	26-lb. U. S.	9.1	10.6	+16.5	12.0	+31.9	80	65	-18.8	86	+ 7.5
9, 8, 12	A	23-lb. European	10.4	10.1	- 2.9	14.1	+35.6	106	78	-26.4	102	- 3.8
9, 8, 12	B	23-lb. European	8.9	9.2	+ 3.4	8.8	- 1.1	55	52	- 5.5	76	+38.2
Average			10.4	10.5	+ 1.0	12.3	+18.3	85	72	-15.3	92	+ 8.2
						35.8, 38-lb. Liners						
15, 14, 18	A	26-lb. U. S.	13.6	14.3	+ 5.1	20.1	+47.8	150	105	-30.0	162	+ 8.0
15, 14, 18	B	26-lb. U. S.	12.2	9.9	-18.9	14.0	+14.8	94	75	-20.2	87	- 7.4
16, 13, 17	A	23-lb. European	11.7	12.9	+10.3	13.4	+14.5	118	105	-11.0	126	+ 6.8
16, 13, 17	B	23-lb. European	10.8	11.3	+ 4.6	12.4	+14.8	94	80	-14.9	92	- 2.1
Average			12.1	12.1	0.0	15.0	+24.0	114	91	-20.2	117	+ 2.6
						41, 42-lb. Liners						
23, 19, 22	A	26-lb. U. S.	15.9	18.4	+15.7	18.6	+17.0	185	154	-16.8	179	- 3.2
23, 19, 22	B	26-lb. U. S.	11.9	13.9	+16.8	13.1	+10.1	104	110	+ 5.8	101	- 2.9
24, 20, 21	A	23-lb. European	12.9	13.5	+ 4.7	17.3	+34.1	153	97	-36.6	113	-26.1
24, 20, 21	B	23-lb. European	11.7	11.9	+ 1.7	13.8	+17.9	98	92	- 6.1	93	- 5.1
Average			13.1	14.4	+ 9.9	15.7	+19.8	135	113	-16.3	122	- 9.6
Overall Average			11.1	11.5	+ 3.6	12.8	+15.3	100	84	-16.0	96	- 4.0

[a] Based on U. S. liner results as reference.

TABLE VI

COMBINED BOARD PROPERTIES
(50% Relative Humidity)

Run	Flute	Type Medium	Basis Weight, lb /M ft^2					Bursting Strength, p s i					Puncture, unit					Average Torsion Tear, in.-oz				
			U S Liner	E G Liner	Diff , %	S C Liner	Diff , %	U S Liner	E.G Liner	Diff %	S C Liner	Diff.., %	U S Liner	E G Liner	Diff.., %	S C Liner	Diff.., %	U S Liner	E G Liner	Diff , %	S.C Liner	Diff , %
									25.6, 26-lb Liners													
3, 2, 6	A	26-lb U S.	102	99	-2.9	97	-4 9	114	204	+78.9	232	+103 5	185	180	-2.7	166	-10.3	215	196	- 8.8	182	-15.3
3, 2, 6	B	26-lb U S.	94	94	0 0	94	0 0	130	168	+29.2	172	+ 32.3	162	160	-1.2	162	0 0	185	176	- 4.9	176	- 4 9
4, 1, 5	A	23-lb European	97	94	-3 1	93	-4 1	149	204	+36 9	236	+ 58.4	171	160	-6.4	156	- 8.8	186	168	- 9.7	176	- 5 4
4, 1, 5	B	23-lb European	91	89	-2 2	89	-2.2	135	182	+34.8	186	+ 37.8	154	144	-6.5	146	- 5.2	159	145	- 8.8	150	- 5.7
Average			96	94	-2 1	93	-3 1	132	190	+43 9	207	+ 56 8	168	161	-4.2	140	-16.7	186	171	- 8.1	171	- 8.1
									30 7, 33-lb. Liners													
10, 7, 11	A	26-lb U S	114	108	-5.3	107	-6 1	218	241	+10 6	232	+ 6.4	200	190	-5.0	192	- 4.0	244	218	-10 7	212	-13.1
10, 7, 11	B	26-lb U S	111	105	-5.4	104	-6.3	184	238	+29 3	214	+ 16 3	192	180	-6.2	175	- 8.9	224	196	-12 5	195	-12.9
9, 8, 12	A	23-lb European	109	104	-4 6	103	-5 5	224	264	+17.9	240	+ 7.1	188	179	-4 8	181	- 3.7	214	196	- 8.4	196	- 8.4
9, 8, 12	B	23-lb European	106	100	-5.7	98	-7.5	206	262	+27.2	232	+ 12.6	173	164	-5.2	162	- 6.4	190	178	- 6.3	167	-12 1
Average			110	104	-5 6	103	-6 4	208	251	+20.7	230	+ 13.5	188	178	-5.3	178	- 5.3	218	197	- 9.6	193	-11.5
									35 8 38-lb. Liners													
15 14, 18	A	26-lb U S	123	119	-3 3	118	-4.1	218	298	+36 7	279	+ 28 0	218	206	-5 5	216	- 0 9	266	242	- 9 0	227	-14 7
15 14, 18	B	26-lb U S	119	114	-4 2	114	-4 2	190	262	+37 9	262	+ 37.9	197	182	-7.6	193	- 2.0	232	217	- 6 5	230	- 0 9
16 13 17	A	23-lb European	118	114	-3.4	113	-4 2	222	298	+34.2	280	+ 26 1	210	194	-7.6	200	- 4 8	246	211	-14 2	218	-11 4
16, 13, 17	B	23-lb European	113	109	-3 5	107	-5.3	219	282	+28.8	272	+ 24 2	184	178	-3.3	173	- 6 0	204	191	- 6.4	198	- 2.9
Average			118	114	-3.4	113	-4.2	212	285	+34.4	273	+ 28 8	202	190	-5.9	196	- 3 0	237	215	- 9.3	218	- 8.0
									41, 42-lb Liners													
23, 19, 22	A	26-lb U S	130	128	-1.5	124	-4.6	240	324	+35 0	297	+ 23 8	232	233	+0.4	234	+ 0 9	280	256	- 8 6	242	-13.6
23 19 22	B	26-lb U S.	126	122	-3 2	118	-6.3	226	258	+14 2	292	+ 29 2	208	204	-1 9	200	- 3.8	258	241	- 6 6	222	-14 0
24, 20, 21	A	23-lb European	126	123	-2 4	120	-4 8	287	322	+12.2	338	+ 17.8	220	208	-5 5	214	- 2 7	255	238	- 6 7	216	-15.3
24, 20, 21	B	23-lb European	120	119	0 8	116	-3.3	235	316	+34.5	310	+ 31 9	196	195	-0.5	186	- 5 1	224	214	- 4.5	204	- 8 9
Average			126	123	-2.4	120	-4.8	247	305	+15.4	309	+ 25.1	212	210	-0.9	209	- 1.4	254	237	- 6.7	221	-13 0
Overall Average			112	109	-2.7	107	-4.5	200	258	+29.0	250	+ 25.0	193	185	-4.1	185	- 4.1	224	205	- 8 5	201	-10.3

TABLE VI continued

COMBINED BOARD PROPERTIES
(50% Relative Humidity)

Run	Flute	Type Medium	Scoreline Torsion Tear, in.-oz.					M.D. Edgewise Compression, lb./in.					C.D. Edgewise Compression, lb./in.					Geometric Mean Flexural Stiffness lb.-in.				
			U S Liner	E G Liner	Diff [a] %	S C Liner	Diff. %	U S Liner	E G Liner	Diff. %	S.C Liner	Diff., %	U.S. Liner	E G Liner	Diff.. %	S C Liner	Diff.. %	U S Liner	E G Liner	Diff. %	S C. Liner	Diff. %
								25.6, 26-lb Liners														
3, 2, 6	A	26-lb U S	202	186	- 7.9	172	-14.9	12.8	9 0	-29.7	11.1	-13.3	37.8	35 3	- 6.6	32.8	-13.2	82.6	87.1	+ 5 4	92 6	+12 1
3, 2 6	B	26-lb U S	177	168	- 5 1	156	-11 9	19.4	18.0	- 7 2	18 9	- 2 6	38.7	36 0	- 7 0	37 8	- 2 3	20 1	33 2	+14 1	32 1	+10 3
4, 1, 5	A	23-lb European	162	151	- 6 8	154	- 4 9	9.7	8.3	-14.4	9 8	+ 1.0	39.8	38 8	- 2 5	36.6	- 8 0	90.8	93.5	+ 3.0	93 0	+ 2 4
4, 1 5	B	23-lb European	152	135	-11.2	141	- 7.2	16 7	17.4	+ 4.2	19 2	+15.0	38.3	39.9	+ 4 2	40.4	+ 5.5	29.8	36 1	+21.1	31.1	+ 4 4
Average			173	160	- 7.5	136	-21.4	14 7	13.2	-10 2	14 8	+ 0.7	38.7	37 5	- 3.1	36.9	- 4 7	58 1	62 5	+ 7 6	62 2	+ 7 1
								30 7, 33-lb Liners														
10 7 11	A	26-lb U S.	204	193	- 5.4	199	- 2 5	14 9	13 6	- 8.7	16 5	+10 7	41.7	38.3	- 8 2	38 7	- 7 2	125'1	134.1	+ 7 2	117 5	- 6 1
10, 7, 11	B	26-lb. U S	208	188	- 9.6	203	- 2 4	29 8	24 8	-16.8	27.6	- 7 4	48.0	45 8	- 4 6	44 0	- 8 3	39.5	46 0	+16 5	38 2	- 3 3
9 8, 12	A	23-lb European	180	172	- 4.4	180	0 0	13 4	13 8	+ 3.0	15 7	+17.2	44.8	41 4	- 7 6	44 0	- 1.8	131 4	144 2	+ 9 7	128 1	- 2 5
9, 8, 12	B	23-lb. European	181	163	- 9 9	168	- 7 2	28 3	25 2	-11 0	23 0	-18 7	49.9	46.6	- 6.6	43 9	-12.0	40 3	42.6	+ 5.7	40 4	+ 0 2
Average			193	179	- 7.3	188	- 2 6	21 6	19 4	-10.2	20 7	- 4.2	46.1	43.0	- 6 7	42.7	- 7 4	84.1	91 7	+ 9 0	81 1	- 3 6
								35.8, 38-lb Liners														
15, 14 18	A	26-lb U S.	227	218	- 4.0	201	-11 5	16 7	18 1	+ 8.4	17 2	+ 3 0	43 9	43.2	- 1.6	45 2	+ 3.0	118 1	168.6	+42 8	132 5	+12 2
15, 14 18	B	26-lb. U S	216	195	- 9.7	226	+ 4 6	31.5	31 8	+ 1.0	28 6	- 9.2	48.3	50 9	+ 5 4	47.0	- 2.7	40 7	53 8	+32 2	43 2	+ 6 1
16, 13 17	A	23-lb. European	203	181	-10.8	201	- 1 0	18.5	17 1	- 7.6	16 0	-13.5	45 8	46.5	+ 1.5	47.4	+ 3.5	122 6	169 3	+38.1	147.4	+20 2
16, 13, 17	B	23-lb European	194	174	-10 3	188	- 3.1	30.5	30 4	- 0 3	28 8	- 5.6	48 8	51.0	+ 4.5	51.7	+ 5.9	39 6	52 0	+31.3	45 3	+14 4
Average			210	192	- 8.6	204	- 2 9	24.3	24 4	+ 0 4	22 7	- 6.6	46 7	47 9	+ 2.6	47.8	+ 2.4	80 2	110 9	+38.3	92 1	+14 8
								41, 42-lb Liners														
23, 19, 22	A	26-lb U S	230	214	- 7 0	204	-11 3	21.2	20 1	- 5 2	23 4	+10.4	47.4	50.1	+ 5 7	47.0	- 0.8	142.2	181.9	+27.9	164.6	+15 8
23, 19, 22	B	26-lb U S	236	224	- 5 1	206	-12.7	37 0	41.0	+10 8	35.2	- 4.9	49 8	52.4	+ 5.2	46 8	- 6 0	42 3	57 8	+36 6	48 0	+13.5
24, 20, 21	A	23-lb European	204	204	0.0	185	- 9.3	21.2	22.2	+ 4.7	25 5	+20 3	50.3	52.2	+ 3 8	53.6	+ 6.6	140 1	203.8	+45.5	166 0	+18.5
24, 20, 21	B	23-lb European	200	204	+ 2.0	191	- 4.5	31 9	38 0	+19 1	35 4	+11.0	52.6	54 0	+ 2.7	52.3	- 0.6	42.6	58 0	+36.2	48 0	+12.7
Average			218	212	- 2 8	197	- 9.6	25 3	30.3	+19 8	27.4	+ 8.3	50.0	52 2	+ 4 4	49.9	- 0.2	91 8	125 4	+36 6	106 7	+16 2
Overall Average			199	185	- 7 0	186	- 6.5	22.1	21.8	- 1.4	22.0	- 0 5	45 4	45.2	- 0 4	44.3	- 2.4	78.6	97.6	+24.2	85.5	+ 8 8

[a] U S liner used as reference

TABLE VII

COMBINED BOARD PROPERTIES
(65% Relative Humidity)

Run	Flute	Type Medium	Basis Weight lb /M ft²					Bursting Strength, p s i					Puncture unit					Average Torsion Tear in -oz				
			U S Liner	E G Liner	Diff.%	S.C Liner	Diff. %	U S Liner	E G Liner	Diff %	S C Liner	Diff. %	U S Liner	E G Liner	Diff. %	S C Liner	Diff. %	U S Liner	E G Liner	Diff. %	S C Liner	Diff. %
25.6, 26-lb. Liners																						
3, 2, 6	A	26-lb U S	104	101	-2.9	99	-4 8	164	228	+39 0	258	+57 3	182	176	-3 3	170	-6.6	236	223	- 5 5	220	- 6 8
3, 2, 6	B	26-lb U S	98	96	-2 0	96	-2 0	132	184	+39.4	236	+78.8	175	170	-2.9	170	-2 9	200	192	- 4 0	194	- 3 0
4, 1, 5	A	23-lb European	99	96	-3.0	95	-4 0	170	202	+18 8	251	+47 6	164	160	-2.4	158	-3.7	200	178	-11 0	202	+ 1 0
4, 1, 5	B	23-lb European	94	91	-3 2	90	-4 3	139	237	+70 5	251	+80 6	168	150	-10 7	154	-8.3	192	174	- 4 4	168	- 2 2
Average			99	96	-3.3	95	-4 4	151	213	+41 1	249	+64.9	172	164	-4 7	163	-10.5	205	192	- 6 3	196	- 4 4
30.7, 33-lb. Liners																						
10, 7 11	A	26-lb U S	116	111	-4.3	110	-5 2	239	290	+21 3	246	+ 2 9	196	195	-0 5	191	-2 6	254	241	- 8 7	238	- 9 8
10, 7, 11	B	26-lb. U S	113	106	-6.2	106	-6.2	208	247	+18 8	238	+14 4	208	190	-8 7	195	-6 2	254	230	- 9 4	222	-12 6
9, 8, 12	A	23-lb European	112	107	-4.5	104	-7 1	250	310	+24 0	258	- 1 5	189	183	-3.2	176	-6.9	246	216	-12.2	206	-16 3
9, 8, 12	B	23-lb. European	110	102	-7.3	101	-8 2	229	287	+25.3	227	- 0 9	183	176	-3.8	182	-0.5	226	202	-10.6	196	-13 3
Average			113	107	-5 3	105	-7 1	232	284	+22.4	242	+ 4 3	194	186	-8.2	186	-8.2	248	222	-10 5	216	-12 9
35 8, 38-lb Liners																						
15, 14, 18	A	26-lb U S	126	123	-2.4	120	-4 8	242	215	+30.2	320	+32 2	216	214	-0 9	216	0 0	298	271	- 9 1	268	-10 1
15 14, 18	B	26-lb U S	121	116	-4 1	115	-5 0	248	295	+19.0	290	+16 9	217	203	-6 5	206	-5.1	266	232	-12 8	246	- 7 5
16, 13, 17	A	23-lb European	122	117	-4 1	116	-4 9	242	322	+33 1	336	+38 8	214	200	-6 5	198	-7 5	274	230	-16 1	255	- 6 9
16 13, 17	B	23-lb European	115	112	-2 6	109	-5.2	251	326	+29 9	320	+27 5	204	192	-5 9	194	-4 9	236	206	-12 7	225	- 3 4
Average			121	117	-3.3	115	-5 0	246	290	+17.9	317	+28 9	213	202	-5 2	204	-4 2	269	235	-12.6	249	- 7 4
41, 42-lb Liners																						
23 19, 22	A	26-lb U S	133	131	-1.5	129	-3 0	260	346	+33.1	348	+33 8	238	230	-3 4	226	-5 0	296	280	- 5.4	272	- 8 1
23, 19, 22	B	26-lb. U. S.	128	126	-1.6	123	-3 9	254	323	+27 2	334	+31 5	230	228	-0.9	217	-5 7	285	253	-11.2	244	-14 4
24, 20, 21	A	23-lb European	128	127	-0.8	122	-4 7	284	347	+22 2	376	+32 4	216	226	+4.6	209	-3 2	282	272	- 3.5	246	-12 8
24, 20, 21	B	23-lb. European	122	121	-0.8	115	-5.7	278	342	+23 0	344	+23.7	211	216	+2.4	204	-3 3	238	240	+ 0 8	216	- 9 2
Average			128	126	-1.6	122	-4 7	269	340	+26.4	351	+30.5	224	225	+0 4	214	-4 5	275	261	- 5 1	245	-10 9
Overall Average			115	111	-3.5	109	-5 2	224	281	+25.4	290	+29.5	201	194	-3.5	192	-4 5	249	229	- 8 0	226	- 9 2

TABLE VII, continued

COMBINED BOARD PROPERTIES

(65% Relative Humidity)

Run	Flute	Type Medium	Scoreline Torsion Tear, in.-oz.					M.D. Edgewise Compression, lb./in.					C.D. Edgewise Compression, lb./in.					Geometric Mean Flexural Stiffness lp.-in				
			U S Liner	E G. Liner	Diff [a] %	S C Liner	Diff , %	U S. Liner	E G Liner	Diff , %	S C Liner	Diff , %	U S Liner	E G Liner	Diff , %	S C Liner	Diff., %	U S Liner	E G. Liner	Diff , %	S C. Liner	Diff , %
										25 6 26-lb Liners												
3 2 6	A	26-lb U S	223	203	- 9.0	194	-13 0	12 2	11 0	- 9 8	12 3	+ 0 8	36.5	34 6	- 5 2	33 7	- 7 7	81 7	93 5	+14 4	85 1	+ 4.2
3, 2, 6	B	26-lb U S	190	192	+ 1 1	178	- 6 3	20 7	18 5	-10 6	19 3	- 6 8	37 7	34 6	- 8 2	36 9	- 2 1	26 2	30 4	+16 0	29 3	+11 8
4 1 5	A	23-lb European	187	164	-12 3	180	- 3 7	11 8	10 2	-13 6	10 9	- 7 6	38 9	37 3	- 4 1	35 8	- 8 0	8[illegible] 4	93 9	+11.3	86 7	- 7
4 1, 5	B	23-lb European	176	163	- 7 4	158	-10 2	20 1	17 6	-12 4	19 6	- 2 5	38 3	37 0	- 3 4	37 9	- 1 0	24 8	31 8	+16 4	28 5	+ 5 3
Average			194	181	- 6 7	178	- 8 2	16 2	14 3	-11.7	15 5	- 4.3	37.9	35 9	- 5 3	36 1	- 4.7	54 8	62 4	+13 9	57 4	+ 4 7
										30 7, 33-lb Liners												
10, 7, 11	A	26-lb U S	234	222	- 5 1	223	- 4 7	15 8	14.2	-10 1	17.2	+ 8 9	41.4	40 5	- 2 2	38 8	- 6.3	111.4	119.1	+ 6 9	111.9	+ 0 4
10, 7, 11	B	26-lb U S.	244	225	- 7.8	223	- 8.6	29 0	25.8	-11 0	26 0	-10.3	43 4	44.0	+ 1 4	41 8	- 3.7	35.5	38 3	+ 7.9	34 7	- 2 3
9, 8, 12	A	23-lb. European	212	193	- 9 0	201	- 5.2	14 7	14.0	- 4 8	16 5	+12 2	43 6	41 4	- 5.0	42.6	- 2.3	110 7	128.4	+16 0	107 5	- 2 9
9, 8, 12	B	23-lb European	207	192	- 7.2	196	- 5 3	27 1	22 8	-15 9	23 6	-12 9	45.1	43.7	- 3.1	45 0	- 0 2	36 0	39 0	+ 8.3	34.7	- 3.6
Average			224	208	- 7 1	211	- 5.8	21.7	19.2	-11.5	20.8	- 4 1	43.4	42 4	- 2.3	42 1	- 3 0	73 4	81 2	+10 6	72 2	- 1 6
										35 8, 38-lb. Liners												
15, 14 18	A	26-lb U S	260	248	- 4.6	247	- 5 0	20 7	19 8	- 4 3	19 4	- 6 3	42.7	43 7	+ 2 3	42 7	0 0	109 6	149.3	+36.2	116 8	+ 6 6
15 14, 18	B	26-lb U S.	242	226	- 6 6	251	+ 3.7	32 2	35 0	+ 8.7	30 6	- 4 7	45 1	46 3	+ 2 7	44.8	- 0.7	37 2	49 8	+33 9	39.2	+ 5.4
16 13 17	A	23-lb European	225	195	-13 3	229	+ 1 8	19 3	18 0	- 6.7	17 4	- 9 8	45.6	46 4	+ 1 8	45.9	+ 0.7	110 3	147 6	+33 8	125.6	+13 9
16, 13, 17	B	23-lb European	205	202	- 1 5	217	+ 5 9	30 7	32 4	+ 5 5	28 5	- 7 2	44 9	50 8	+13.1	48 1	+ 7.1	37 4	48 9	+30 7	41 3	+10.4
Average			233	218	- 6.4	236	+ 1 3	25 7	26.3	+ 2 3	24 0	- 6 6	44 6	46.8	+ 4 9	45.4	+ 1.8	73 6	98 9	+34.4	80 7	+ 9 6
										41, 42-lb Liners												
23, 19 22	A	26-lb U S	255	251	- 1 6	239	- 6 3	23 7	26.5	+11 8	24 0	+ 1.3	46.9	48 6	+ 3 6	47.2	+ 0 6	122.3	163.7	+33 9	137 8	+12 7
23 19 22	B	26-lb. U S	265	241	- 9.1	241	- 9 1	36 9	40 0	+ 8.4	40 1	+ 8 7	47 1	48 8	+ 3.6	45 3	- 3 8	41.0	53 9	+31.5	48 1	+17.3
24, 20 21	A	23-lb European	235	238	+ 1 3	207	-11.9	20 9	24 5	+17 2	25 6	+22 5	50 0	50 9	+ 1 8	50 5	+ 1.0	123.8	160 5	+29.6	135.4	+ 9.4
24, 20, 21	B	23-lb European	222	207	- 6 8	212	- 4 5	35 3	38.9	+10.2	38 0	+ 7 6	49 8	50 3	+ 1 0	48 9	- 1.8	39 6	56 4	+42 4	44 1	+11 4
Average			244	234	- 4 1	225	- 7 8	29 2	32.5	+11.3	31.9	+ 9.2	48.5	49.7	+ 2.5	48 0	+ 1 0	81 7	108 6	+32 9	91 3	+11 8
Overall Average			224	210	- 6.3	212	- 5 4	23 2	23.1	- 0 4	23 1	- 0 4	43 6	43 7	+ 0 2	42 9	- 1 6	70 9	87.8	+23 8	75.4	+ 6 3

[a] U S liner used as reference

TABLE VIII

COMPARISON OF OBSERVED AND COMPUTED TOP LOAD COMPRESSION VALUES
(50% Relative Humidity)

Run	Liner Weight, lb /M sq ft	Medium Weight, lb /M sq ft	Top Load Compression, lb					Top Load Compression, lb				
			Observed	Computed (Long Form)	Diff , %[a]	Computed (Short Form)	Diff , %[a]	Observed	Computed (Long Form)	Diff , %[a]	Computed (Short Form)	Diff , %[a]
			A-Flute					B-Flute				
3	US-26	US-26	530	559	+5 4	573	+8 1	460	436	-5 2	449	-2 3
10	US-33	US-26	595	668	+12 2	635	+6 8	545	554	+1.7	562	+3.1
15	US-38	US-26	635	684	+7 7	681	+7 2	565	560	-0 8	571	+1 0
23	US-42	US-26	730	759	+4 0	733	+0 5	590	579	-1 9	591	+0 2
2	EG-25 6	US-26	510	538	+5 5	531	+4 0	445	427	-3 9	414	-6 9
7	EG-30 8	US-26	615	638	+3 7	576	-6 4	545	556	+2 0	529	-2 9
14	EG-35 9	US-26	690	738	+7 0	663	-3 9	600	626	+4 3	594	-1 1
19	EG-41 0	US-26	775	842	+8 7	771	-0 5	640	651	+1 7	619	-3 3
6	SC-25 6	US-26	520	517	-0 5	494	-4 9	440	439	-0 1	435	-1 2
11	SC-30 8	US-26	610	622	+1 9	585	-4 1	525	514	-2 0	513	-2 3
18	SC-35 9	US-26	640	720	+12 4	696	+8 7	590	558	-5 5	548	-7 1
22	SC-41 0	US-26	715	783	+9 5	729	+2 0	640	571	-10 8	555	-13 2
Av			--	--	6.5	--	4.9	--	--	3 3	--	3 7
4	US-26	F-23	565	595	+5 3	606	+7 3	465	436	-6 3	443	-4 8
9	US-33	F-23	590	713	+20 9	681	+15 4	545	573	+5 1	577	+5 8
16	US-38	F-23	660	713	+8 0	701	+6 3	560	561	+0 2	569	+1 6
24	US-42	F-23	725	791	+9 1	768	+6 0	575	604	+5 1	616	+7 1
1	EG-25 6	F-23	520	588	+13 1	583	+12 2	435	471	+8 4	455	+4 6
8	EG-30 8	F-23	595	689	+15 8	626	+5 2	555	552	-0 5	531	-4 3
13	EG-35 9	F-23	675	782	+15 9	710	+5 2	635	621	-2 2	592	-6 8
20	EG-41 0	F-23	815	894	+9 7	801	-1 2	630	666	+5 8	627	-0 5
5	SC-25 6	F-23	530	562	+6 0	553	+4 4	435	458	+5 3	460	+5 9
12	SC-30 8	F-23	625	699	+11 9	665	+6 4	515	521	+1 2	505	-1 9
17	SC-35 9	F-23	630	766	+21 6	724	+14 9	585	606	+3 6	600	+2 6
21	SC-41 0	F-23	740	865	+16 9	823	+11 2	650	620	-4 6	615	-5 3
24A	US-26	F-26	545	608	+11 6	613	+12 4					
24B	US-33	F-26	655	744	+13 6	717	+9 5					
24C	US-38	F-26	645	745	+15 5	744	+15 4					
24D	US-42	F-26	730	795	+9 0	780	+6 9					
Av					12 1		8 8			4 0		4 3
Grand Av					10 0		7.0			3 6		4 0

[a] Based on observed values as reference

Note Long form $P = 2\ 0277\ P_m^{0\ 7462} \left(\sqrt{D_x D_y}\right)^{0\ 2538} z^{0\ 4924}$

Short form $P = 5\ 8745\ P_m\ h^{0\ 5076} z^{0\ 4924}$

TABLE IX

COMPARISON OF OBSERVED AND COMPUTED TOP LOAD COMPRESSION VALUES
(65% Relative Humidity)

Run	Liner Weight, lb./M sq. ft	Medium Weight, lb./M sq. ft	Top-Load Compression, lb. Observed	Computed (Long Form)	Diff., %[a]	Computed (Short Form)	Diff., %[a]	Top-Load Compression, lb Observed	Computed (Long Form)	Diff., %[a]	Computed (Short Form)	Diff., %[a]
					A-Flute					B-Flute		
3	US-26	US-26	490	543	+10.8	560	+14.4	405	416	+ 2.8	440	+ 8.5
10	US-33	US-26	560	645	+15.2	632	+12.9	495	500	+ 1.0	508	+ 2.7
15	US-38	US-26	600	657	+ 9.6	659	+ 9.8	535	520	- 2.7	535	0.0
23	US-42	US-26	670	725	+ 8.2	726	+ 8.3	570	551	- 3.3	559	- 1.9
2	EG-25.6	US-26	465	540	+16.1	520	+11.8	425	406	- 4.5	398	- 6.3
7	EG-30.7	US-26	540	645	+19.5	614	+13.6	510	515	+ 0.9	511	+ 0.2
14	EG-35.8	US-26	605	723	+19.6	671	+10.9	570	572	+ 0.3	545	- 4.4
19	EG-41.0	US-26	750	802	+ 6.9	748	- 0.3	620	607	- 2.2	577	- 7.0
6	SC-25.6	US-26	470	517	+ 9.9	509	+ 8.4	405	422	+ 4.2	424	+ 4.8
11	SC-30.7	US-26	545	615	+12.9	594	+ 9.0	495	483	- 2.4	487	- 1.5
18	SC-35.8	US-26	625	668	+ 6.9	654	+ 4.6	570	525	- 7.9	525	- 7.9
22	SC-41.0	US-26	685	751	+ 9.6	728	+ 6.3	580	557	- 3.9	538	- 7.3
Average					12.1		9.2			3.0		4.4
4	US-26	F-23	520	574	+10.3	591	+13.7	450	424	- 5.8	447	- 0.8
9	US-33	F-23	540	669	+24.0	664	+23.0	500	516	+ 3.2	524	+ 4.7
16	US-38	F-23	600	692	+15.3	696	+16.1	510	520	+ 1.9	526	+ 3.1
24	US-42	F-23	675	763	+13.0	772	+14.3	515	570	+10.6	586	+13.8
1	EG-25.6	F-23	515	571	+11.0	564	+ 9.5	420	430	+ 2.3	424	+ 0.9
8	EG-30.7	F-23	545	669	+22.7	626	+14.8	480	515	+ 7.2	505	+ 5.2
13	EG-35.8	F-23	610	754	+23.7	711	+16.5	620	610	- 1.7	590	- 4.9
20	EG-41.0	F-23	735	826	+12.3	781	+ 6.3	600	628	+ 4.6	589	- 1.8
5	SC-25.6	F-23	455	543	+19.4	534	+17.3	395	427	+ 8.2	434	+ 9.9
12	SC-30.7	F-23	575	653	+13.6	651	+13.2	470	511	+ 8.6	522	+11.1
17	SC-35.8	F-23	615	718	+16.8	703	+14.3	525	561	+ 6.8	558	+ 6.4
21	SC-41.0	F-23	625	786	+25.8	775	+24.1	580	577	- 0.5	575	- 0.8
24A	US-26	F-26	645	738	+14.5	742	+15.1					
24B	US-33	F-26	605	694	+14.8	710	+17.3					
24C	US-38	F-26	580	675	+16.3	674	+16.2					
24D	US-42	F-26	495	568	+14.8	588	+18.8					
Average					16.8		15.7			5.1		5.3
Grand Average					14.8		12.9			4.0		4.7

[a] Based on observed values as reference.

Note Long form: $P = 2.028\, P_m^{0.746}\, (\sqrt{D_x D_y})^{0.254}\, z^{0.492}$

Short form: $P = 5.87\, P_m\, h^{0.50}\, z^{0.492}$

TABLE X

COMPARISON OF PHYSICAL CHARACTERISTICS OF DOMESTIC AND EUROPEAN LINERS
(50% Relative Humidity)

Test Property	U.S. Liner 26-lb.	Difference[a], % Eur. 25.6-lb. E.G.	S.C.	U.S. Liner 33-lb.	Difference[a], % Eur 30 7-lb. E.G.	S.C.	U.S. Liner 38-lb.	Difference[a], % Eur 35.8-lb E.G.	S.C.	U.S. Liner 42-lb.	Difference[a], % Eur. 41.0-lb. E G.	S C.
Weight, lb./M sq. ft.	28.0	- 5.4	- 4.6	35.0	- 9.1	-11.4	39.4	- 5.1	- 7.6	42.8	- 2.8	- 7.5
Caliper, pt.	9.6	-18.8	-18.8	9.8	-10.2	- 1.0	11.2	-10.7	-11.6	12.1	- 4.1	- 0.8
Apparent density	3.0	+13.3	+13.3	3.6	0.0	-11.1	3.6	+ 5.6	+ 2.8	3.6	0.0	-11.1
Bursting strength, p.s.i.g	72	+38.9	+47.2	105	+18.1	+ 6.7	98	+38.8	+38.8	115	+27.0	+19.1
p.s.i./lb.	2.57	+46.7	+54.5	3.0	+30.0	+20.3	2.49	+46.2	+50.2	2.69	+30.5	28.6
Elmendorf tear, in-machine												
g./sheet	202	-17.8	-29.2	240	-17.9	-11.7	275	-10.5	-10.5	292	- 1.0	- 9.6
factor	7.21	-13.2	-25.7	6.86	- 9.8	- 0.3	6.98	- 5.7	- 3.2	6.82	+ 1.9	- 2.2
Elmerdorf tear, cross-machine												
g /sheet	250	-18.4	-25.6	308	-18.2	-22.7	344	-11.3	-15.4	364	- 3.0	-14.0
factor	8.93	-13.8	-21.9	8.08	-10.0	-12.7	8.73	- 6.5	- 8.5	8.50	- 0.1	- 7.1
Average, ir and cross	226	-18.6	-27.4	274	-17.9	-17.5	310	-11.0	-13.5	328	- 2.1	-12.2
Torsion tear, in-machine												
unit	50	-12.0	-10.0	60	-16.7	- 8.3	71	-29.6	- 9.9	70	-15.7	-11.4
factor	1.79	- 7.3	- 5.6	1.71	- 8.2	+ 3.5	1.80	-25.6	- 2.2	1.64	-13.4	- 4.3
Torsion tear, cross-machine												
unit	56	-14.3	- 7.1	74	-25.7	-29.7	83	-28.9	-21.7	86	-16.3	-22.1
factor	2.00	- 9.5	- 2.5	2.11	-18.0	-20.4	2.11	-25.1	-15.2	2.01	-13.9	-15.9
Average, unit	52	-11.5	- 7.7	66	-21.2	-19.7	77	-28.6	-16.9	78	-15.4	-16.7
Puncture, ir-machine												
unit	20	-10.0	-20.0	24	-12.5	-16.7	28	- 7.1	- 7.1	32	- 3.1	-12.5
factor	0.71	- 4.2	-15.5	0.69	- 4.3	- 5.8	0.71	- 1.4	0.0	0.75	0.0	- 5.3
Puncture, cross-machine												
unit	20	-10.0	-20.0	24	- 8.3	-12.5	28	- 7.1	- 7.1	32	0.0	-12.5
factor	0.71	- 4.2	-15.5	0.67	0.0	- 1.4	0.71	- 1.4	0.0	0.75	+ 2.7	- 5.3
Average, unit	20	-10.0	-20.0	24	- 8.3	-16.7	28	- 7.1	- 7.1	32	0.0	-12.5
Modified ring compression, in-machine												
lb./in.	16.0	+ 0.6	+ 8.8	23.4	- 8.1	-14.5	24.0	+ 2.5	- 4.2	19.3	+17.1	+ 7.8
factor	0.57	+ 7.0	+14.0	0.67	+ 1.5	- 3.0	0.61	+ 8.2	+ 3.3	0.45	+20.0	+17.8
cross-machine												
lb./in.	11.4	- 0.9	+ 2.6	16.0	- 5.0	-11.2	15.6	+14.1	+ 5.8	15.4	+ 7.8	+ 3.9
factor	0.41	+ 4.9	+ 7.3	0.46	+ 4.3	0.0	0.40	+20.0	+12.5	0.36	+11.1	+11.1

[a] U.S. liner used as reference

TABLE X continued

COMPARISON OF PHYSICAL CHARACTERISTICS OF DOMESTIC AND EUROPEAN LINERS

(50% Relative Humidity)

Test Property	U.S. Liner 26-lb.	Difference[a], % Eur. 25.6-lb. E.G.	Eur. 25.6-lb. S.C.	U.S. Liner 33-lb.	Difference[a], % Eur. 30.7-lb. E.G.	Eur. 30.7-lb. S.C.	U.S. Liner 38-lb.	Difference[a], % Eur. 35.8-lb. E.G.	Eur. 35.8-lb. S.C.	U.S. Liner 42-lb.	Difference[a], % Eur. 41.0-lb. E.G.	Eur. 41.0-lb. S.C.
Taber stiffness, in-machine												
g. cm	26	-23.1	-15.4	40	- 7.5	+ 5.0	53	0.0	- 9.4	68	+14.7	+23.5
factor	0.93	-19.4	-11.8	1.14	+ 1.8	+18.4	1.35	+ 5.2	- 2.2	1.59	+18.2	+33.3
Taber stiffness, cross-machine												
g. cm	10	-20.0	-20.0	14	- 7.1	0.0	16	+31.2	+12.5	23	+30.4	+17.4
factor	0.36	-16.7	-16.7	0.40	+ 2.5	+12.5	0.41	+36.6	+19.5	0.54	+33.3	+25.9
Tensile strength, in-machine												
lb./in.	57.0	+39.6	+57.5	86.6	+23.6	+13.2	86.0	+35.8	+29.1	95.2	+31.7	+32.8
factor	2.04	+47.1	+64.7	2.47	+36.0	+27.9	2.18	+43.1	+39.9	2.22	+35.6	+43.7
Tensile strength, cross-machine												
lb./in.	22.2	+37.8	+18.9	30.2	+25.2	+29.8	28.9	+63.3	+58.5	32.9	+54.1	+41.0
factor	0.79	+45.6	+25.3	0.86	+38.4	+46.5	0.73	+72.6	+72.6	0.77	+58.4	+51.9
Stretch, %												
in-machine	1.8	+ 5.6	+22.2	2.2	- 9.1	-13.6	2.0	-10.0	+15.0	2.2	-18.2	- 9.1
cross-machine	3.1	+45.2	+58.1	3.6	+19.4	+41.7	4.4	-22.7	+22.7	3.8	-10.5	+23.7
Modulus of elasticity,												
$(16^2 \times 10^3)$ in-machine	647	+52.9	+60.7	870	+33.8	+ 3.1	782	+42.5	+22.8	771	+37.5	+22.3
cross-machine	271	+35.1	+18.8	354	+20.9	- 2.3	279	+68.5	+35.5	300	+51.3	+10.3
T.E.A., in.lb./in.^{2}												
in-machine	0.71	+33.8	+71.8	1.24	+ 8.1	- 4.8	1.14	+19.3	+44.7	1.36	+11.0	+14.0
cross-machine	0.53	+38.7	+84.9	0.85	+40.0	+68.2	1.00	+15.0	+78.0	0.95	+28.4	+67.4
Transverse bond, kg.cm./sec.												
in-machine	4.34	-23.5	+13.1	4.55	- 7.3	+51.6	3.24	+24.7	+70.1	4.76	- 9.9	+23.1
cross-machine	3.13	-24.9	-19.8	2.26	+ 2.7	+39.8	1.68	+34.5	+57.1	2.27	+ 5.3	+13.7
Porosity, sec./100 cc.	13	+84.6	+207.7	38	+257.9	-31.6	29	+369.0	+120.7	28	+289.3	+135.7
Smoothness, ml./min.	987	=22.5	-13.1	498	+97.6	+66.7	616	+49.2	-19.2	700	+36.6	+50.3
Cobb size, g./in.^{2}	38.5	- 3.4	- 2.9	35.6	+21.6	+ 7.6	36.5	- 1.9	+ 0.3	33.2	- 2.4	+11.4

[a] U. S. liner used as reference.

TABLE XI

COMPARISON OF PHYSICAL CHARACTERISTICS OF DOMESTIC AND EUROPEAN LINERS
(65% Relative Humidity)

Test Property	Difference[a], % U.S. Liner 26-lb.	Eur. 25.6-lb. E.G.	S.C.	Difference[a], % U.S. Liner 33-lb.	Eur. 30.7-lb. E.G.	S.C.	Difference[a], % U.S. Liner 38-lb.	Eur. 35.8-lb. E.G.	S.C.	Difference[a], % U.S. Liner 42-lb.	Eur. 41.0-lb. E.G.	S.C.
Weight, lb./M sq. ft.	28.2	- 2.8	- 4.3	35.7	- 9.2	-11.8	40.0	- 4.8	- 6.2	43.7	- 3.8	- 8.5
Caliper, pt.	10.0	-20.0	-20.0	10.0	-12.0	- 1.0	11.4	- 8.8	-10.5	12.4	- 4.8	0.0
Apparent density	2.8	+21.4	+21.4	3.6	0.0	-11.1	3.6	+ 2.8	+ 2.8	3.5	+ 2.9	- 8.6
Bursting strength, p.s.i.g.	70	+37.1	+52.9	104	+18.3	+11.5	98	+37.8	+39.8	113	+27.4	+25.7
p.s.i./lb.	2.48	+41.1	+59.7	2.91	+30.6	+26.5	2.45	+44.5	+49.0	2.59	+31.3	+37.1
Elmendorf tear, in-machine												
g./sheet	228	-17.5	-29.8	270	016.3	- 7.0	308	- 7.5	- 8.4	326	- 0.6	- 7.1
factor	8.09	-15.2	-26.7	7.56	- 7.7	+ 5.4	7.70	- 2.9	- 2.3	7.46	+ 2.4	+ 1.6
Elmendorf tear, cross-machine												
g./sheet	284	-19.7	-26.4	342	-17.0	-19.9	387	-10.1	-16.3	401	- 4.2	-12.7
factor	10.07	-17.4	-23.1	9.58	- 8.5	- 9.2	9.68	- 5.7	-10.7	9.18	- 1.3	- 4.7
Average, in and cross	250	-16.8	-26.4	306	-16.7	-14.4	248	- 8.9	-13.2	364	- 2.7	-10.2
Torsion tear, in-machine												
unit	58	-10.3	- 8.6	68	-20.6	- 5.9	77	-19.5	- 1.3	83	-14.6	- 7.3
factor	2.06	- 7.8	- 4.9	1.90	-12.1	+ 6.8	1.92	-15.1	+ 5.7	1.88	-12.2	+ 1.1
Torsion tear, cross-machine												
unit	68	-16.2	- 8.8	85	-20.0	-27.1	94	-20.2	-12.8	104	-15.4	-23.1
factor	2.41	-13.7	- 4.6	2.38	-11.8	-17.2	2.35	-16.2	- 6.8	2.38	-12.6	-16.0
Average, unit	62	-12.9	- 6.5	76	-18.4	-18.4	85	-17.6	- 5.9	93	-16.1	-16.1
Puncture, in-machine												
unit	20	-10.0	-20.0	25	-12.0	-12.0	30	- 6.7	-13.3	34	0.0	-11.8
factor	0.71	- 7.0	-16.9	0.70	- 2.9	0.0	0.75	- 2.7	- 8.0	0.78	+ 2.6	- 3.8
Puncture, cross-machine												
unit	20	- 5.0	-20.0	26	-15.4	-15.4	31	- 9.7	-16.1	34	0.0	-11.8
factor	0.71	- 2.8	-16.9	0.73	- 6.8	- 4.1	0.78	- 6.4	-11.5	0.78	+ 2.6	- 3.8
Average, unit	20	- 5.0	-20.0	26	-15.4	-15.4	30	- 6.7	-13.3	34	0.0	-11.8
Modified ring compression, in-machine												
lb./in.	15.4	+ 3.2	+ 7.8	23.2	- 6.9	-13.8	23.7	+ 3.8	- 1.7	20.8	+ 8.2	+ 1.0
factor	0.55	+ 5.5	+10.9	0.65	+ 3.1	- 3.1	0.59	+10.2	+ 5.1	0.48	+10.4	+10.4
cross-machine												
lb./in.	10.8	- 1.9	+ 0.9	14.9	- 4.7	- 6.0	14.6	+13.7	+ 9.6	15.8	+11.4	+ 2.5
factor	0.38	+ 2.6	+ 5.3	0.42	+ 4.8	+ 4.8	0.36	+22.2	+19.4	0.36	+16.7	+11.1

[a] U.S. liner used as reference.

TABLE XI-continued

COMPARISON OF PHYSICAL CHARACTERISTICS OF DOMESTIC AND EUROPEAN LINERS
(65% Relative Humidity)

Test Property	Difference[a], % U.S. Liner 26-lb.	Eur. 25.6-lb. E.G.	Eur. 25.6-lb. S.C.	Difference[a], % U.S. Liner 33-lb.	Eur. 30.7-lb. E.G.	Eur. 30.7-lb. S.C.	Difference[a], % U.S. Liner 38-lb.	Eur. 35.8-lb. E.G.	Eur. 35.8-lb. S.C.	Difference[a], % U.S. Liner 42-lb.	Eur. 41.0-lb. E.G.	Eur. 41.0-lb. S.C.
Taber stiffness, in-machine												
g. cm	25	-20.0	-12.0	38	0.0	+10.5	52	+ 3.8	- 7.7	68	+20.6	+27.9
factor	0.89	-18.0	- 9.0	1.06	+10.4	+25.5	1.30	+ 9.2	- 1.5	1.56	+23.7	+39.7
Taber stiffness, cross-machine												
g. cm	10	-40.0	-30.0	14	-14.3	0.0	16	+25.0	+ 6.2	24	+25.0	+ 4.2
factor	0.35	-37.1	-25.7	0.39	- 5.1	+12.8	0.40	+30.0	+12.5	0.55	+29.1	+12.7
Tensile strength, in-machine												
lb./in.	52.8	+42.8	+66.3	81.5	+22.0	+11.7	80.4	+35.2	+28.1	89.5	+29.2	+30.9
factor	1.87	+47.1	+73.8	2.28	+34.6	+26.8	2.01	+41.8	+36.8	2.05	+33.2	+42.9
Tensile strength, cross-machine												
lb./in.	20.8	+43.3	+21.6	28.2	+28.7	+33.3	27.0	+65.9	+62.2	31.2	+55.1	+37.2
factor	0.74	+47.3	+27.0	0.79	+41.8	+50.6	0.68	+73.5	+72.1	0.71	+60.6	+50.7
Stretch, %												
in-machine	2.0	0.0	+20.0	2.4	-16.7	-16.7	2.2	- 9.1	+ 9.1	2.4	-16.7	-12.5
cross-machine	3.8	+31.6	+47.4	4.2	+14.3	+35.7	5.1	-25.5	+17.6	4.2	- 9.5	+21.4
Modulus of elasticity,												
($16^2 \times 10^3$) in-machine	590	+58.0	+61.5	814	+32.7	+ 5.7	729	+43.2	+23.3	724	+37.2	+20.2
cross-machine	239	+39.3	+18.8	316	+19.0	- 2.5	246	+69.1	+37.4	269	+49.8	+ 7.8
T.E.A., in.lb./in.^{2}												
in-machine	0.74	+32.4	+75.7	1.29	+ 2.3	-11.6	1.19	+14.3	+37.8	1.38	+ 5.8	+11.6
cross-machine	0.60	+73.3	+76.7	0.92	+34.8	+60.9	1.06	+11.3	+72.6	1.02	+25.5	+52.9
Transverse bond, kg.cm./sec.												
in-machine	1.96	- 9.2	+ 1.0	217	- 1.8	+ 5.5	1.92	- 1.0	+18.8	2.12	- 4.7	+17.9
cross-machine	1.85	- 9.7	+ 3.8	1.89	+12.2	+18.5	1.89	+ 1.6	+ 4.8	1.85	+ 8.6	+17.8
Porosity, sec./100 cc.	10	+120.0	+222.0	31	+303.2	-32.3	28	+292.9	+96.4	25	+300.0	+136.0
Smoothness, ml./min.	1108	-27.1	-31.1	606	+49.7	+44.2	666	+36.9	-32.4	692	+42.6	+54.6
Cobb size, g./in.^{2}	33.6	- 2.1	+ 0.6	33.0	+18.8	+ 4.2	32.7	- 2.1	- 2.1	28.8	- 0.3	+16.3

[a] U.S. liner used as reference.

TABLE XII

COMPOSITE AVERAGE

(Liner Characteristics)

Test Property	Difference, % *			
	50% Relative Humidity		65% Relative Humidity	
	E.G.	S.C.	E.G.	S.C.
Weight, lb./M sq. ft.	- 2.9	- 7.8	- 5.2	- 7.7
Caliper, pt.	-11.0	- 8.1	-11.4	- 7.9
Apparent density	+ 4.2	- 0.8	+ 6.8	+ 1.1
Bursting strength, p.s.i.g.	+30.7	+28.0	+30.2	+32.5
p.s.i./lb.	+38.4	+38.4	+36.9	+43.1
Elmendorf tear, in-machine				
g./sheet	-11.8	-15.3	-10.5	-13.1
factor	- 6.7	- 7.9	- 5.9	- 5.5
Elmendorf tear, cross-machine				
g./sheet	-12.7	-19.4	-12.8	-18.8
factor	- 7.6	-12.6	- 8.2	-11.9
Average, in and cross	-12.4	-17.7	-11.3	-16.1
Torsion tear, in-machine				
unit	-18.5	- 9.9	-16.3	- 5.8
factor	-21.3	- 2.2	-11.8	+ 2.2
Torsion tear, cross-machine				
unit	-21.3	-20.2	-18.0	-18.0
factor	-16.6	-13.5	-13.6	-11.2
Average, unit	-19.2	-15.3	-16.3	-11.7
Puncture, in-machine				
unit	- 8.2	-14.1	- 7.2	-14.3
factor	- 2.5	- 6.7	- 2.5	- 7.2
Puncture, cross-machine				
unit	- 6.4	-13.0	- 7.5	-15.8
factor	- 0.7	- 5.6	- 3.4	- 9.1
Average, unit	- 9.5	-11.0	- 6.8	-15.1
Modified ring compression, in-machine				
lb./in.	+ 3.0	+ 1.6	+ 2.1	- 2.2
factor	+ 9.2	+ 8.0	+ 7.3	+ 5.8
cross-machine				
lb./in.	+ 4.0	+ 2.8	+ 4.6	+ 1.8
factor	+10.1	+ 7.7	+11.6	+10.2

* Based on domestic results as reference

TABLE XII continued

COMPOSITE AVERAGE

(Liner Characteristics)

Test Property	Difference, % *			
	50% Relative Humidity		65% Relative Humidity	
	E.G.	S.C.	E.G.	S.C.
Taber stiffness, in-machine				
g. cm	- 4.0	+ 0.9	+ 1.1	+ 7.4
factor	+ 1.5	+ 9.4	+ 6.3	+13.7
Taber stiffness, cross-machine				
g. cm	+ 8.6	+ 2.5	- 1.1	- 4.9
factor	+13.9	+18.7	+ 4.2	+ 3.1
Tensile strength, in-machine				
lb./in.	+32.7	+33.2	+32.3	+34.3
factor	+40.5	+44.1	+39.2	+45.1
Tensile strength cross-machine				
lb./in.	+45.1	+37.1	+48.3	+38.6
factor	+53.8	+49.1	+55.8	+50.1
Stretch, %				
in-machine	- 7.9	+ 3.6	-10.6	0.0
cross-machine	+ 7.9	+36.6	+ 2.7	+30.5
Modulus of elasticity,				
$(16^2 \times 10^3)$ in-machine	+41.2	+27.2	+42.7	+27.7
cross-machine	+44.0	+15.6	+44.3	+15.4
T.E.A., in.lb./in.^{2}				
in-machine	+18.1	+31.4	+13.7	+28.4
cross-machine	+43.0	+74.6	+36.2	+65.8
Transverse bond, kg.cm./sec.				
in-machine	- 4.0	+39.5	- 4.2	+10.8
cross-machine	+ 4.4	+22.7	+ 3.2	+11.2
Porosity, sec./100 cc.	+250.2	+108.1	+254.0	+105.5
Smoothness, ml./min.	+40.3	+21.2	+25.5	+ 8.8
Cobb size, g./in.^{2}	+ 3.5	+ 4.1	+ 3.6	+ 4.8

* Based on domestic results as reference.

TABLE XIII

PHYSICAL CHARACTERISTICS OF TEST MEDIUMS

		50% R.H.					65% R.H.				
		26-lb U.S. Medium	23-lb. Eur. Medium	Diff., %[a]	26-lb Eur. Medium	Diff., %[a]	26-lb U.S. Medium	23-lb Eur. Medium	Diff., %[a]	26-lb Eur. Medium	Diff., %[a]
Basis weight, lb./M sq. ft.		26.4	23.2	- 12.1	26.3	- 0.4	26.8	23.5	- 12.3	26.4	- 1.5
Caliper, pt.		10.4	8.9	- 14.4	9.0	- 13.5	10.5	9.0	- 14.3	9.8	- 6.7
Apparent density		2.5	2.6	0.0	2.9	+ 11.5	2.6	2.6	0.0	2.7	+ 3.8
Concora flat crush, p.s.i.		32.2	32.2	- 1.8	32.6	- 1.5	31.6	26.4	- 16.5	33.3	+ 5.4
Water drop, sec.		94	592+	+423.4+	100	- 6.4	115	600+	+421.7	132	+ 14.8
Elmendorf tearing strength,											
In-machine	g./sheet	96	63	- 34.4	65	- 32.3	111	74	- 33.3	80	- 27.9
	factor	3.64	2.72	- 25.3	2.47	- 32.1	4.14	3.15	- 23.9	3.03	- 26.8
Cross-machine,	g./sheet	120	76	- 36.7	94	- 21.7	137	86	- 37.2	109	- 20.4
	factor	4.55	3.28	- 27.9	3.57	- 21.5	5.11	3.66	- 28.4	4.13	- 19.2
Av., in-cross,	g./sheet	108	69	- 36.1	80	- 25.9	124	80	- 35.5	94	- 24.2
Modified ring compression,											
In-machine,	lb./in.	17.6	17.1	- 2.8	19.3	+ 9.7	16.5	16.2	- 1.8	18.3	+ 10.9
	factor	0.67	0.74	+ 10.4	0.73	+ 9.0	0.62	0.69	+ 11.3	0.69	+ 11.3
Cross machine,	lb./in.	12.8	14.0	+ 9.4	14.0	+ 9.4	11.7	12.8	+ 9.4	13.0	+ 11.1
	factor	0.48	0.60	+ 25.0	0.53	+ 10.4	0.44	0.54	+ 22.7	0.49	+ 11.4
Taber stiffness,											
In-machine,	g. cm	15	10	- 33.3	18	+ 20.0	14	10	- 28.6	18	+ 28.6
	factor	0.57	0.43	- 24.6	0.68	+ 19.3	0.52	0.43	- 17.3	0.68	+ 30.8
Cross-machine,	g. cm	8	8	0.0	10	+ 25.0	7	6	- 14.3	8	+ 14.3
	factor	0.30	0.34	+ 13.3	0.38	+ 26.7	0.26	0.26	0.0	0.30	+ 15.4
Tensile strength,											
In-machine,	lb./in.	46.8	51.5	+ 10.0	63.4	+ 35.5	43.3	49.0	+ 13.2	60.6	+ 40.0
	factor	1.77	2.22	+ 25.4	2.41	+ 36.7	1.62	2.09	+ 29.0	2.30	+ 42.0
Cross-machine,	lb./in.	19.0	26.7	+ 40.5	26.4	+ 38.9	17.4	25.2	+ 44.8	24.6	+ 41.4
	factor	0.72	1.15	+ 59.7	1.00	+ 38.9	0.65	1.07	+ 64.6	0.93	+ 43.1
Stretch, %											
	In	1.8	1.6	- 11.1	1.5	- 16.7	2.0	1.8	- 10.0	1.6	- 20.0
	Cross	2.6	1.8	- 30.8	2.0	- 23.1	3.2	2.1	- 34.4	2.2	- 31.2
Modulus of elasticity,											
p.s.i. x 10^3	In	500	635	+ 27.0	804	+ 60.8	465	603	+ 29.7	708	+ 52.3
	Cross	212	373	+ 75.9	355	+ 67.5	190	341	+ 79.5	304	+ 60.0
T.E.A., in.lb./in.^{2}											
	In	0.58	0.53	- 8.6	0.59	+ 1.7	0.56	0.56	0.0	0.62	+ 10.7
	Cross	0.38	0.32	- 15.9	0.38	0.0	0.43	0.37	- 14.0	0.38	- 11.6
Puncture, unit											
	In	9	6	- 33.3	7	- 2.2	10	6	- 40.0	8	- 20.0
	Cross	9	6	- 33.3	8	11.1	10	6	- 40.0	8	- 20.0
Av., In and Cross		9	6	- 33.3	8	11.1	10	6	- 40.0	8	- 20.0
Torsion tear, in.-oz											
	In.	24	12	- 50.0	13	- 45.8	32	16	- 50.0	16	- 50.0
	Cross	26	12	- 53.8	16	- 38.5	34	16	- 52.9	20	- 41.2
Av., In and Cross		26	12	- 53.8	14	- 46.2	34	16	- 52.9	18	- 47.1
Porosity,											
Porosity, sec./100 cc		18	34	+ 88.9	18	0.0	24	32	+ 33.3	18	- 25.0

[a] U.S. 26-lb. medium used as reference